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INDICATIONS OF A GIGANTIC AMPHIBIAN IN THE COAL MEASURES OF KANSAS,
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Indications of a Gigantic Amphibian in the Coal Measures of Kansas.

By H. T. MARTIN,
Associate Curator, Paleontological Museum, University of Kansas.

INTRODUCTION.

IN the summer of 1919, Robert and James Coghill, students of the University of Kansas, discovered in the sandstone cliffs bordering the Wakarusa creek, five miles east of Lawrence, what to them appeared to be the footprints of some large animal impressed in the hard, sandy bottom of a small, narrow ravine that empties into Wakarusa creek from the east near Dightman bridge. The writer's attention was called to the find, and a visit to the locality revealed three or four tracks exposed to view. Unfavorable weather conditions prevented the removal of the tracks at the time, and the subsequent rains covered them with silty mud. It was not until the spring rains of 1921 had again washed them clear that work on their removal could be carried on. By this time additional tracks were exposed, and in a distance of thirty-nine feet, where the animal had traveled in a nearly direct line, nine very fine impressions of his huge feet were recorded.

The impressions, although in a nearly straight line, were not in consecutive order. As shown in the diagram (plate I, figs. 1 to 9), one space of twelve feet from the first track to the second was eroded and no impressions remained. Midway between the third and the fourth, a distance of eight feet, there is an indication of a track, but with no character. From track four to track five the bottom of the ravine is still covered with mud, and it is possible that more tracks will be found here. Eight of the tracks have been safely removed and placed in the museum. The first in the series

yet remains *in situ*, but will be removed in the spring. The first impression in the series occurs at the mouth of the small ravine, where it empties over the edge of the deeply undercut, rocky, shelving bank into the Wakarusa. At this point the smooth, level bed of the creek is composed of the same sandy formation (plate II) as that in which the tracks appear. From the bed of the creek to the level of the first track there is an elevation of fourteen feet. This track, like several others in the set, shows the imprint of more than one foot. It also shows plainly that the animal must have been of great size and weight, for from the marks made by the claws (plate I, fig. 10) of the front foot, at the extreme upper edge of the basinlike cavity each impression has made, to the level of the superimposed impression of the hind foot there is a depth of over fifteen inches. It may be doubted if an animal of less than from 400 to 500 pounds weight could possibly have left as deep an imprint as is here shown. From the first track to the second, a distance of twelve feet, there is an elevation of three feet.

There is no doubt that the animal was well adapted for traveling on land, as well as for life in the wet and swampy marshes, and that its body was carried clear of the ground, requiring relatively long limbs. The imprints also indicate that an upright position was maintained, the toes of the feet being planted in a straight line parallel to the body and to the line of travel. The footprints suggest that the animal was of very robust build, possibly not unlike that of *Eryops* from the Permian of Texas, but probably of longer limb. It may well be that the form described herewith as *Onychopus gigas* is a Carboniferous representative of this well-known fossil amphibian, or some similar animal with a longer length of limb.

Onychopus gigas gen. et sp. nov.

An entirely new form of amphibian is indicated by the present series of footprints, for which the term *Onychopus gigas* is proposed. The generic term refers to the presence of claws, apparently for both fore and hind feet. Claws are known among previously described Paleozoic vertebrates, particularly among the Permian reptiles, but are here regarded as a generic character. Their presence is indicated in the long, sharply marked grooves on the edges of the footprints, where the sluggish animal lazily dragged his feet from the soft sand. Another new character is an apparent presence of heel pads (plate I, figs. 2-10), which are represented in the footprints as depressions at the base of the footprint. Further discoveries may

locate the form in a genus of reptiles or amphibians already known, but for the present the footprints indicate an unknown animal.

Additional characters are indicated in the apparent presence of webs between the toes, extending a short distance on the phalanges. The body and the tail were carried clear of the ground, as there is no evidence of dragging. This is all the more unusual in view of the great depth of the impressions. The length of his sluggish stride was 450 mm.; the manus was 90 mm. in length and the pes 104 mm. Other detailed measurements are given in the description of the plate.

The most nearly related form is *Baropus lentus*, described by Marsh, from the Coal Measures of Osage county, Kansas (1). The present form differs from *Baropus* in being somewhat larger, and especially in the indications of the heel pads and claws. None of the other Coal Measures footprints from Kansas approach the present footprints in size save *Dromopus agilis* Marsh (2), from which it is clearly separated by a number of characters.

The present series of footprints have been compared with the descriptions of Coal Measures footprints given by King, Leidy, Lea, Butts, Marsh, Mudge, Dawson, Moore, Cox, Moodie and Woodsworth, a list of whose writings relating to this subject is to be found in Moodie's memoir (2) on "The Coal Measures Amphibia of North America." The present form is widely separated from the footprints recently described by Lull (3) as *Dromopus (?) woodworthi*, from the Coal Measures of Massachusetts.

It has been assumed, on account of the indications of four toes on the manus and five on the pes, that *Onychopus gigas* was an amphibian, though the discovery of skeleton material may make this assumption unwarranted. In view of the possibility of its being reptilian, the present footprints have been carefully compared with those described by Hitchcock (4), but none similar in form are found.

FORMATION.

The massive reddish-brown sandstone in which the tracks were found contains abundant flaky scales of mica. There are no perceptible lines of stratification and no lines of cleavage. The rocks are split up by horizontal, perpendicular and oblique cracks and fissures into sections of erratic shapes and sizes (plate II). A careful examination failed to reveal any invertebrates or other fossil forms in the sandstone bluffs, although remains of Coal Measures plants have been found elsewhere in this horizon.

The bottom of the ravine containing the tracks scales off more readily than the surrounding bluffs and is consequently rapidly eroding away. The banks of the ravine are very steep, the average width at the bottom being about 3 feet, with a width at the top of 25 feet, while the depth from the level of the banks above to the level of the tracks is 25 feet.

CORRELATION OF FORMATION.

The heavy sandstone rocks in which the impressions appear are exposed in a sharp escarpment on the south side of the Wakarusa creek for a distance of 1½ to 2 miles, in varying heights ranging from a thin feathering edge to 40 feet. The highest point is attained in close proximity to and just above the small ravine in which the tracks were discovered.

A short distance southwest, at the extreme eastern end of Blue Mound, and just above these exposures, an outcrop of the Iatan limestone occurs, thus definitely placing the sandy exposures in the division which composes the lowest member of the Douglas formation, and as it occurs immediately below the Iatan limestone constitutes a part of the uppermost strata of the Weston shales.

The inclusion of this heavy sandstone in the Weston shales will be better understood by referring to the description of the Douglas formation by Moore (5):

"The shale members of the Douglas are variable in composition and texture, changing markedly from point to point. In the north there is a predominance of clay shales, which is sufficiently pure for use in brick manufacture, but towards the south the proportion of sand is notably increased. In places here the shale is replaced by thick, massive sandstones. Coal occurs at one or two horizons in the formation, but is not of great thickness and has been worked only locally."

DESCRIPTION OF TRACKS.

Track No. 1, the first in the series, shows clearly where the front foot had pressed down in the soft, plastic mud to a depth of eight inches, leaving at this level a well-defined ledge. Immediately behind this narrow ledge the superimposed hind foot had pressed down to a depth of another seven inches, plainly indicating that the animal was of large size and great weight. This impression represents the tracks of the front and the hind foot of the left side.

Track No. 2. (Plate I, fig. 2.) This track was located 12 feet from No. 1 and is one of the finest in the set, showing distinctly the impressions of five bluntly pointed toes. Between the toes the weight of the animal has caused the mud to ooze up, not in sharp

ridges as one would expect if the animal had separate unwebbed phalanges, but in a smooth, rounding ridge, indicating that either a fleshy pad, or more likely a thick web, extended to the base of the short, blunt claws. The hinder part of the impression has unfortunately eroded away, so that no imprint of the heel is retained. Both the manus and the pes are represented here, and naturally that of the pes shows most distinctly. Towards the hinder part of the impression there is a small, round indentation, as if caused by a conical protuberance beneath the pad of the foot, as indicated in other tracks of the series. The elevation from the first track to the second is three feet.

Track No. 3. (Plate I, fig. 3.) This track was exactly two feet from its predecessor, measurements in each instance being made from the centers of the impressions. There are four distinct toe marks in this track, evidently a left manus. This track, like No. 2, was in a shelving, badly eroded place, leaving no imprint of the palm. From this track to No. 9, the last in the series, there is an elevation of 3 feet.

Track No. 4. (Plate I, fig. 4.) This impression was separated by eight feet of clear space from No. 3, and it has the least character of any in the set. There are four light toe marks, and two of the small, round depressions at the base of the palm. These were made, no doubt, by round, warty tubercles beneath the foot. The relative position of the toe imprints to each other indicates a right manus, but so indistinct are the surface toe marks that it is doubtful if they do not belong to the left instead of the right.

Track No. 5. (Plate I, fig. 5.) From the fourth to the fifth track there is a space of ten feet, covered to a depth of several inches with soft mud and yet unexplored. Future rains will doubtless disclose more impressions. Track No. 5 shows deep scoring on the edges of the depressions by the slipping of the claws. The four grooves thus made end with the same number of round pits, pressed a half inch or more below the level of the palm, while at the base of the palm one of the small circular pits occurs. These small pits appear at the base of each palm and sole wherever the conditions are favorable enough to retain the imprint of the hinder part of the foot. There is no doubt but that this track represents the impression of the left manus.

Track No. 6. (Plate 1, fig. 6.) Impression No. 6, two feet six inches from No. 5, is similar in all respects to others already described, and is the left pes.

Tracks Nos. 7 and 8. (Plate 1, figs. 7 and 8.) These two tracks were removed in one block. The distance of stride from No. 6 to No. 7 was two feet six inches. Here the animal changed its course and turned sharply to the left, making a short step of only twelve inches from track seven to track eight. Each of these tracks were pressed firmly into the sandy matrix, making a bowl-shaped depression, with sloping sides, twelve inches in diameter and six inches deep. Grooves in the sides of the depressions show distinctly where the toes and the pad of the front foot have pressed down to a depth of four inches. At this level there is a slight ledge left where the overlapping hind foot pressed still deeper down for another three inches, leaving a well-defined imprint of the short claws and the circular pits similar to those found at the base of the palm and sole of the other tracks collected.

Track No. 9. (Plate 1, fig. 9.) This, the last track of the series, was situated two feet three inches from the preceding track, and six inches higher in elevation. This probably is of the left side, but whether of the manus or pes is rather doubtful. The imprint, being on higher and drier ground, was less distinct and showed less character than those made in more plastic material. The bank rises rapidly from the last track found, and although the overlying soil was cleared away for quite a space around, no other indications of tracks could be found.

The finding of these scarce footprints in the Coal Measures of Kansas will be welcomed because they may shed some light on the ancestors of the later Permo-Carboniferous amphibians, or possibly reptilian fauna of that age.

Thanks are here expressed to the finders of these rare tracks for their generosity in presenting them to the paleontological department of the University of Kansas.

I wish to express my thanks to Dr. Roy L. Moodie, College of Medicine of the University of Illinois, to whom I am under obligations for assistance in the preparation of this paper.

CONCLUSIONS.

The present series of footprints referred to under the new term of *Onychopus gigas* indicates one of the largest, if not actually the largest, pre-Triassic vertebrate thus far known from the geological horizons of the world. A short-bodied, long-limbed vertebrate with well-developed feet left these impressions, of whose bodily structure nothing whatever is known. So deeply marked are the footprints

in the sandstone that it looks as if an elephant had recently waded through. A curious consistency of the sandy shale is indicated in the well-preserved indications of foot structure of *Onychopus gigas* as he trailed through the sandy mud many millions of years ago. It is extremely interesting to note the change in elevation between track one and track nine. While this may be due to the dip of the strata, it may also indicate the shelving bank of a Coal Measures stream which has again been exposed by the gradual erosion of the present Wakarusa creek.

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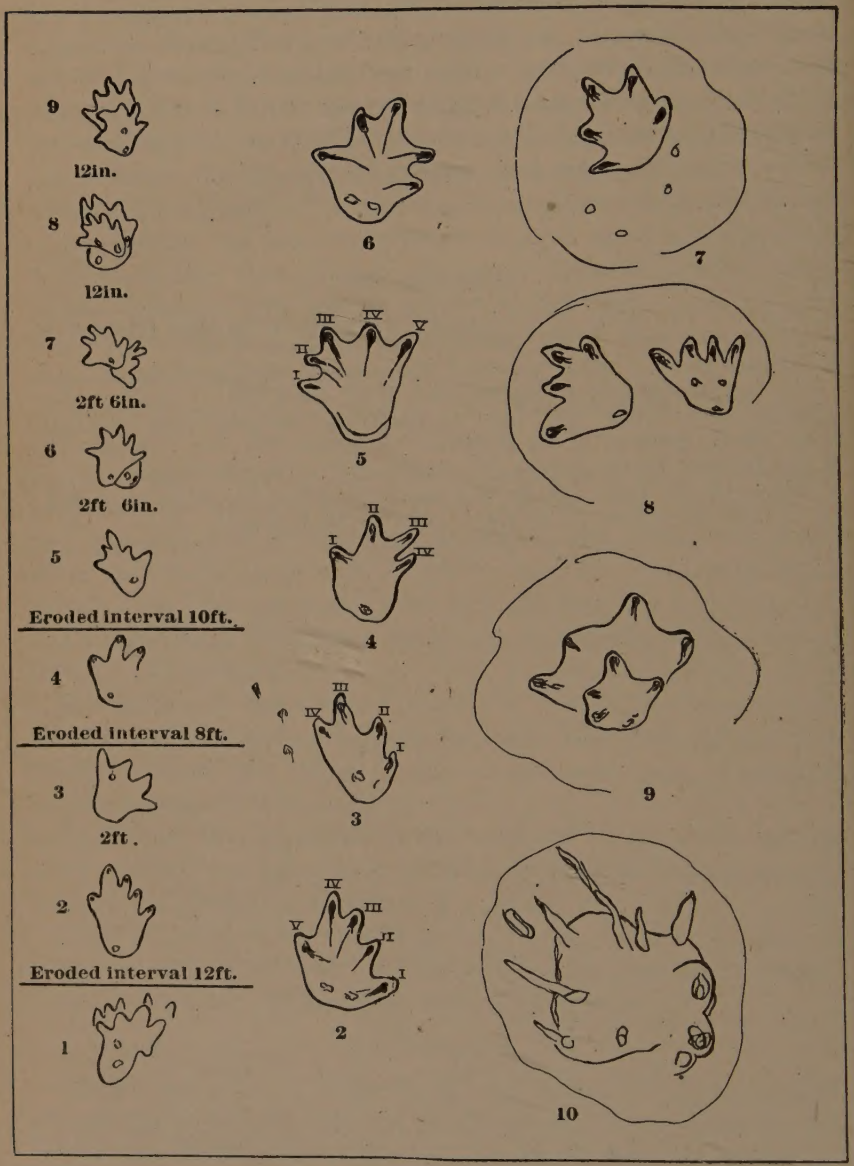
FOOTPRINTS OF A GIGANTIC AMPHIBIAN.
H. T. Martin.

PLATE I.



EXPLANATION OF PLATE I.

The small figures on the left, from 1 to 9, indicate the series of amphibian footprints in the sandstone ledge of the Upper Coal Measures. After making the sixth impression the animal turned sharply to the left, so that the drawing does not represent exactly the manner of occurrence. It shows, however, the distance between impressions. No. 1 is possibly a fore-foot impression, with portions of another; No. 2, the left pes; No. 3, the left manus; No. 4, indefinite; No. 5, left pes; No. 6, left pes, part manus; No. 7, left pes, part left manus; No. 8, left pes, part manus; No. 9, undecided.

The figures 2 to 10 on the right of the plate are detailed studies of the best-preserved tracks.

No. 2, left pes with a distance of 130 mm. across the heel impressions at the level of digit I. The distance between the tips of digits I and II, II and III, III and IV is in each case 40 mm.; between IV and V is 80 mm. Small pits in the heel impression indicate heel pads.

No. 3, left manus. The small pits to the left indicate toe marks of another foot. The greatest width of this foot is 105 mm. The distance between the tips of digits I and II, II and III is in each case 50 mm.; between III and IV is 40 mm.

No. 4, right manus. The distance from the tip of digit III to the posterior edge of the heel pad is 95 mm.; between II and III, 45 mm.; between I and II, 48 mm.

No. 5, right pes. The greatest length is 110 mm.; the greatest width 120 mm.

No. 6, undoubtedly a pes, with well-marked heel pads. The greatest length is 140 mm., the greatest width 144 mm.

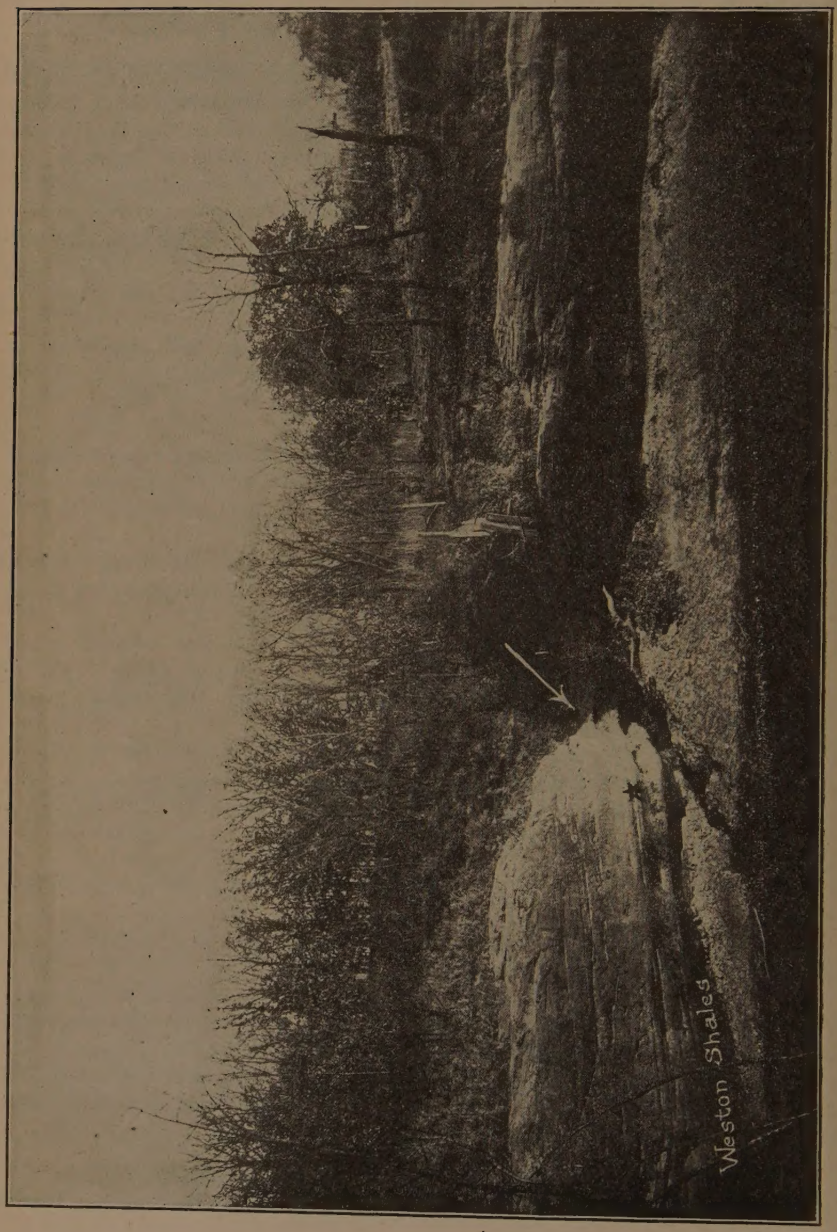
No. 7, a pes. The impressions below the pes represent a second impression, which was probably obliterated by the hind foot. The circle surrounding the footprints represents the edge of a three-inch depression in which the footprints occurred. This indicates both the great weight of the animal and the softness of the ground.

No. 8, a part of pes and manus, also occur in a depression three inches deep.

No. 9 shows two superimposed impressions of a fore and a hind foot. The greatest width of the hind foot is 135 mm.

No. 10 is a sketch of the appearance of the depression, showing the shape of the depression and the long furrows made by dragging blunt claws along a moist surface. Claws have been previously indicated in the remains of the larger Permian and Triassic amphibians, in the presence of blunt terminal rugose phalanges, but so far as I am aware no impressions of them have been so clearly recorded in the rocks of the Coal Measures.

PLATE II.



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EXPLANATION OF PLATE II.

Photograph of the east bank of the Wakarusa creek at Dightman's crossing, five miles southeast of Lawrence, Kan., showing the relation of the heavily bedded sandstone, in which the amphibian footprints were found, to the Weston shales which outcrop immediately at the edge of the water. The ravine in the center of the picture has a depth from the surface of twenty feet, and in this depression, on the ledge indicated at the point of the arrow, was found the series of footprints shown in the plate. This ledge at the position of the first track lies fourteen feet above the creek, but the stratum rises three feet between the first and the second impressions, between which there is an eroded interval of twelve feet. A further inclination of the stratum is indicated in the fact that there is a rise of four feet between the second and the last impressions, a distance of twenty-seven feet. The ledge on which the impressions were found is continued into the sandstone cliff immediately above the star (*).

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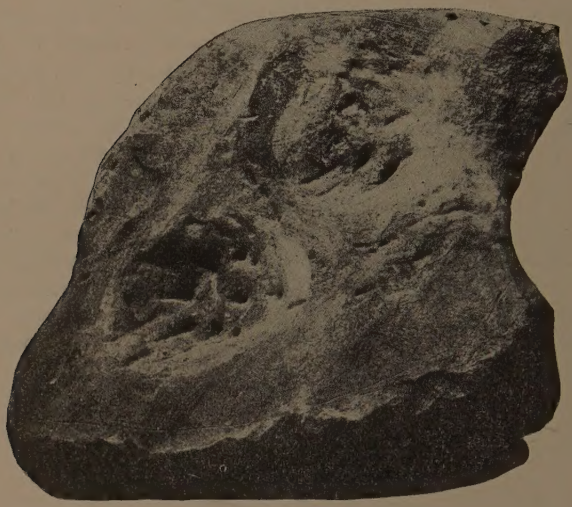

PLATE III.

Photographs of tracks Nos. 8 and 9, showing the imprint of both the front and the supraimposed hind foot on each impression.